Cultural Management Studies on Upland Taro: Effects of Population Density and Planting Method on Growth and Yield

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The effects of population density and planting methods on the growth and yield of upland taro were studied. Leaf area per plant decreased whereas leaf area index (LAI) increased as population density increased. As LAI increased up to 4.75, the relative corn yields increased in all treatments. The main corn yield per plant decreased as plant population increased. However, the total corn yield per unit area increased as population density increased. The hole planting method gave higher leaf area per plant at all population levels, yield per plant, and total yield per unit area as compared to the flat method.

Key words: Colocasia esculenta, corm yield, leaf area index, planting method, planting population.

In cereal and other grain crops, an increase in planting density has been found to increase total yield despite strong indications that individual plant productivity is reduced (Andrew, 1967). Bridge et al. (1978) suggested that mutual shading of adjacent plants is the main factor that reduces yield. However, other workers believe that as population increases, there is a greater competition for water, carbon dioxide and other growth factors. The immediate effect of this seemed to be on foliage development which is largely a major determinant of yield (Weber et al., 1966).

In taro (Colocasia esculenta), previous studies (Pardales and Villanueva, 1981; Pardales et al., 1982; Villanueva et al., 1983) showed that the total main corn yield increased with an increase in population but the individual corn became smaller as planting stand became denser. The same trend was observed also by Villamayor and Apilar (1981) in cassava.

The earlier management studies on taro which dealt partly with plant population did not consider the relationship between the agronomic attributes and population density and the factors that affect growth and development under highly competitive conditions. Furthermore, the influence of planting method on taro production has not been elucidated properly. This study, therefore, aimed to investigate the effects of the two methods of planting and planting density on the vegetative development, yield and yield components of taro under upland condition.

MATERIALS AND METHODS

The variety of taro used was “Kalpao” (PR-G 068).

* Funded jointly by the International Foundation for Science (Sweden) and Philippine Root Crops Research and Training Center.

The planting material (sett) consisted of about 2 cm of the upper part of the corn containing the growing point and 20-25 cm of the lower portion of the petioles.

Two field plantings were made in 1982 on a clay loam soil in the experimental field inside the Visayas State College of Agriculture campus. The first cropping was established in March and the second in April. The crops in both plantings were harvested after eight months. A strip plot design with three replications was used in both plantings. The first main treatment of plant population consisted of three levels as follows: (1) 26,667, (2) 40,000, and (3) 53,333 plants/ha which were established using the planting distance of 50 x 75 cm, 50 x 50 cm and 50 x 37.50 cm, respectively.

The second treatment was the method of planting consisting of flat and hole methods. The former was done by digging a hole in the soil just enough for the sett to fit and covering its base totally with loose dirt. No furrows were made. In the latter method, a hole 10-12 cm deep and about as wide was first prepared. A sett was put into it and the hole was partially covered with loose dirt leaving the upper one-half of the entire depth uncovered. Both planting methods are commonly practiced by taro farmers in the locality.

At planting time a fertilizer rate equivalent to 15-15-15 kg/ha N, P₂O₅ and K₂O were applied to the crop. The same dosage was applied when the plants were 60 days old. Weeds were controlled by hand weeding. In both croppings, rainfall was limited such that four supplemental irrigations were administered to the crops.

Vegetative parameters like plant height and leaf area were determined at monthly intervals from 10 sample plants every subplot. The leaf area of taro was calculated by adopting the procedure developed by Pardales (1980).
RESULTS AND DISCUSSION

Leaf Area Development. Leaf area development was affected greatly by plant population but not by the planting method when the data of the two croppings were averaged. Regression analysis indicated a linear reduction in the leaf area per plant as the plant population was increased (Fig. 1). The regression line for the hole method of planting was also significantly higher than that for the flat method. However, the slopes of the regression line, \( Y = 14.447 - 0.140X \) and \( Y = 10.640 - 0.110X \), were not significantly different. This suggests that the hole method brought about more favorable effects on the leaf area development of the crop at all population levels compared to the flat method. Apparently, the hole around the base of the plants afforded better water retention after each supplemental irrigation, hence, giving the plants adequate moisture for over a relatively longer period of time than when they are planted using the flat method. Another possible explanation is that since the plants were established deeper in the hole method (the holes being 10-12 cm deep), their roots could have access to sufficiently available water normally found in deeper soil layers. However, the similar regression lines of the two planting methods suggest that other factors might be responsible for limiting the leaf area development of the plants in the higher population levels. It is possible that as the population density increases plant competition for solar radiation and probably CO\(_2\) becomes greater resulting in a reduction in leaf area/plant. This situation may have been aggravated by the fact that taro has broad leaves so that mutual shading becomes a common phenomenon especially at closer planting scheme. As observed, from the fourth month after planting (MAP) until the eight MAP, leaf area per plant at higher population levels was consistently smaller than that in the lower level.

Leaf area of taro was consistently smaller in the April planting. This may be due to the difference in the total environmental condition that prevailed during the growth of each crop which could have also brought about the difference in their yield level.

Leaf area index (LAI) increased correspondingly with the increase in plant population (Fig. 2). This may imply that in taro, the rate of reduction in leaf area per plant was lower than the rate of increase in total leaf area as the plant population was increased. This result corroborates the observation reported for cassava (Villamayor and Apilar, 1981) and grain crops (Nunez and Kamprath, 1969; Fischer and Wilson, 1976). The relationship between LAI and plant population was linear \( Y = 1.670 + 0.114X \) when taro was planted in holes. A quadratic equation \( Y = 7.534 - 0.385X + 0.006X^2 \) defined more precisely their relationship when the crop was established in flat method. Comparatively, hole planting brought about greater LAI at all population levels than flat planting.

Corn Yield. Regardless of planting method, a reduction in weight of main corn/plant resulted as plant population was increased (Fig. 3). Corn yield of the

![Figure 1. Leaf area of taro per plant at 4 MAP as influenced by plant population and method of planting (O — hole planting, first cropping; △ — hole planting, second cropping; ● — flat planting, first cropping; ▲ — flat planting, second cropping).](image1)

![Figure 2. Leaf area index of taro at 4 MAP as influenced by plant population and method of planting (O — hole planting, first cropping; △ — hole planting, second cropping; ● — flat planting, first cropping; ▲ — flat planting, second cropping).](image2)
individual plant was found to be positively correlated to the leaf area/plant ($r=0.887^*$ and $r=0.928^{**}$ respectively, for flat and hole planting), suggesting that a reduction in the potential leaf area would reduce correspondingly the yield per plant. A greater degree of overlapping of the leaves of adjacent plants in the higher stand density was observed; thus, it appears that competition for solar radiation, among other growth factors, was very intense under high population level. Although the two planting methods brought about differential yield levels at all plant populations their rate of yield reduction followed an almost similar pattern and magnitude so that it could be assumed that regardless of planting method, interplant competition is of relatively the same intensity under a given population level. Between planting methods, hole planting brought about greater yield per plant than flat planting.

Total yield of main corms increased as plant population increased. Again this implies that the rate of reduction in the weight of individual corm is slower than the rate of increase in the total weight of the corms. Since weight of main corm in taro is related to its size, the decrease in individual corm size with increasing population level was more than offset by the yield from the additional plants per unit area. Furthermore, the result indicates that the total yield in taro is a function of the number of corms produced per unit area rather than the size of the individual corm. The same was noticed by Villanueva et al. (1983) in upland taro and Pardales et al. (1982) in lowland taro. This general tendency of taro to increase its total yield proportionately with plant population could be due to the higher number of plants per unit area of land which could intercept effectively solar radiation and thereby enhance photosynthesis on a unit area basis. The report made by Ezumah and Plucknett (1973) affirms the above idea of taro productivity in relation to stand density.

When the main corn yield data were averaged across population density, a significant effect of planting method was obtained only in the March planting but not in the April planting. In the first cropping, the main corn yield was significantly higher in the hole method (13.85 tons/ha) as compared to the flat method (10.03 tons/ha). Although no significant effect was observed in the second planting, the main corn yield was greater in value (9.58 tons/ha) under the hole planting than under the flat planting method (8.83 tons/ha). The factors discussed earlier which could have brought about better leaf area development in taro planted in holes could have likewise encouraged greater corn yield under such planting method.

Leaf Area Index and Corm Yield. As leaf area index increased, the relative yield of taro increased correspondingly (Fig. 4). Each point in the same area in Fig. 4 represents a relative yield value as affected by method of planting in the two croppings under the same plant population level. Hence, it is implied that in taro both LAI and total yield are determined by the stand density of the crop. It may be worthwhile noting that the magnitude of increase in LAI was greater when plant population was increased from 40,000 plant per ha to 53,333 than from 26,666 to 40,000. Under this study, optimum yields were obtained at LAI around 4.75.

Figure 3. Main corm yield per hectare vs. main corm yield per plant as influenced by plant population and method of planting.

Figure 4. Relationship between leaf area index and relative yield of taro at three planting density in the two cropping made.
LITERATURE CITED


